6.0 HYDRAULIC ANALYSIS

6.1 INTRODUCTION

Hydraulic analyses were performed on Cool Creek and its major tributaries to identify existing problem areas, identify floodplain limits for unmapped tributaries, and to develop solutions to stream related flooding areas. The analyses were performed using HEC-RAS (U. S. Army Corps of Engineers, Hydrologic Engineering Center – River Analysis System, version 3.0.1, March 2001).

The following sections provide an overview of HEC-RAS, the analysis using the existing FIS models, summarizes the development and analysis results of the new HEC-RAS models of the unmapped tributary, and the results of the floodplain mapping.

6.2 HEC-RAS OVERVIEW

HEC-RAS is an integrated package of hydraulic analysis programs and a Graphical User Interface (GUI). The system is capable of performing steady flow water surface profile calculations (note: a recent release of HEC-RAS also includes provisions for unsteady flow analysis).

A HEC-RAS "Project" is a set of data files associated with a stream system. The data files for a typical project include plan data, geometric data, and flow data. Plan data defines the geometry and flow data that are to be used, a description and identifier for the model run, and other simulation options. Geometric data consist of stream cross-section data and hydraulic structure data (bridges, culverts, weirs, etc.). Channel and floodplain roughness coefficients (n-values), ineffective flow areas, and levees can also be specified in geometric data. Flow data includes the number of profiles to be calculated and the peak flow data for each stream reach and profile (i.e. 2-year, 10-year, 100-year).

HEC-RAS results can be viewed in both tabular and graphical form. Figure 6-1 illustrates several of the graphical user interface elements.

6.3 HEC-RAS MODEL DEVELOPMENT

6.3.1 Existing FIS Model – Conversion to HEC-RAS

The existing HEC-2 Flood Insurance Study models obtained from IDNR (Section 2.4.1 of Chapter 2) were converted to HEC-RAS models using the *import routine* provided with HEC-RAS. Importing a HEC-2 data set usually requires some modifications to the data, particularly at bridges and culverts, as the bridge routines in HEC-RAS are more detailed than HEC-2. The HEC-RAS model output was very close to the original HEC-2 flood elevations.

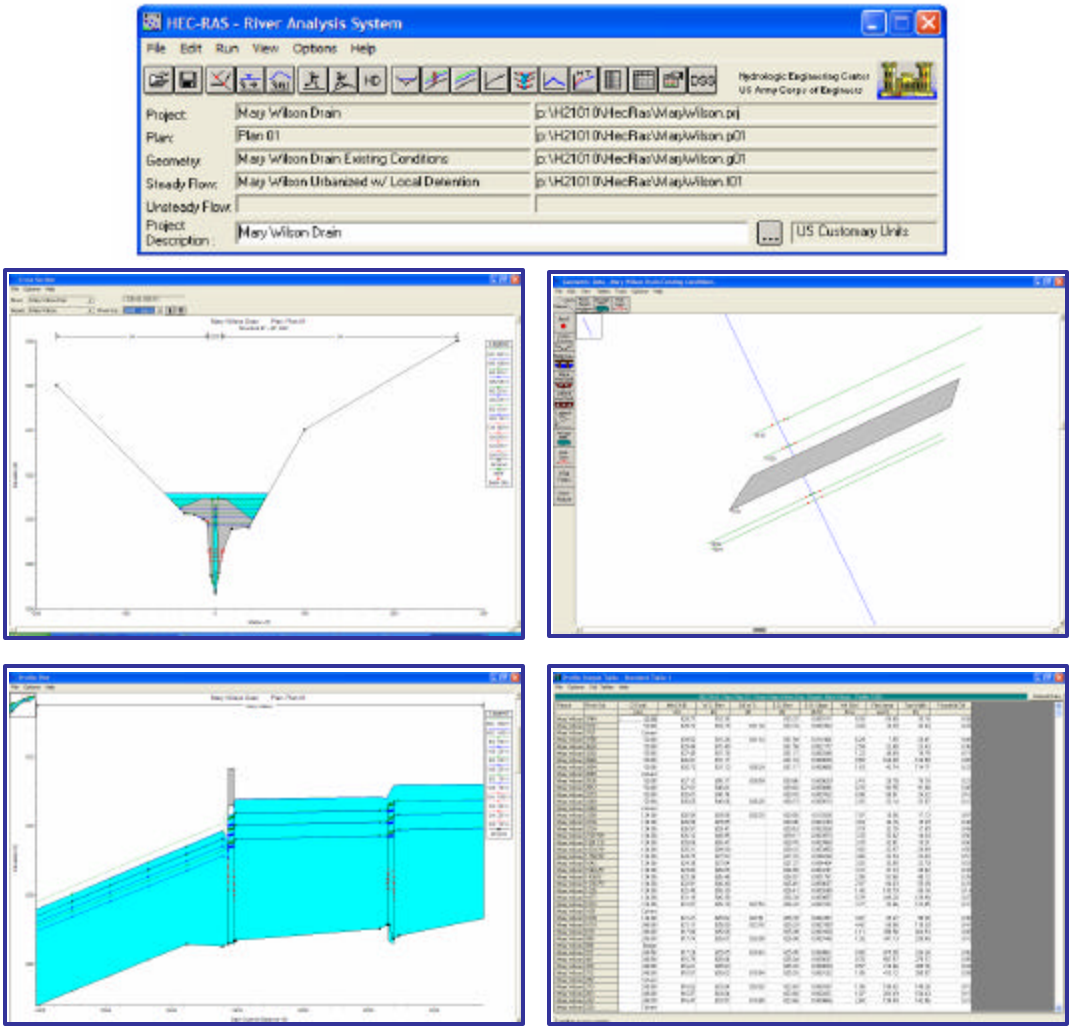

Figure 6-1
HEC-RAS Graphical User Interface

6.3.2 New HEC-RAS Models

New HEC-RAS models were developed for four minor tributaries that have not previously been analyzed:

- Mary Wilson Drain
- H.G. Kenyon Drain
- J.M. Thompson Drain
- Highway Run

Field surveying of the four unmapped tributaries was completed in April 2002. Surveys were based on benchmark information provided by the Hamilton County Surveyor's Office. Table 6-1 summarizes the number of cross-sections and hydraulic structures surveyed on each tributary.

Table 6-1
Hydraulic Survey Summary

Stream	Number of Cross-Sections	Number of Structures
Mary Wilson Drain	18	8
H.G. Kenyon Drain	28	9
J.M. Thompson Drain	12	3
Highway Run	21	10

A Hydraulic Survey Report was prepared and transmitted under separate cover to Hamilton County. The report includes cross-section and structure sketches, photographs of each structure, and field notes. Cross-sections were surveyed and sketched looking downstream. The cross-section sketches list the station offset (from the centerline of the channel) and corresponding elevation for each surveyed point on the cross-section. Structure sketches included station and elevation data along with measurements for culvert size or bridge waterway opening size, pier configuration and size, rail configuration and size, roadway elevation and width, wing wall size and configuration, and other information as applicable.

The above geometry data was input into the HEC-RAS model for each tributary. A copy of the HEC-RAS input and output is provided in Appendix F. Peak flows were computed from the HEC-HMS model (Chapter 5) and input into the HEC-RAS models at locations summarized in Table 6-2. The 3-hour duration storm produced the highest peak flows which were used as inputs to the HEC-RAS models.

Table 6-2
100-Year Flow Summary – New HEC-RAS Models

Stream	Distance Above Mouth (feet)	100-Year Flow (cfs)
Mary Wilson Drain	1010	392
	2350	196
	3740	80
H.G. Kenyon Drain	3307	484
	4654	300
	6864	200
	8172	104
J.M. Thompson	1403	488
	2207	350
	3221	200
Highway Run	1920	510
	2386	425
	2784	350
	4733	186

6.4 RESULTS

6.4.1 New HEC-RAS Model Results

Flood elevations for the four previously unmapped tributaries were computed using HEC-RAS. The resulting 100-year flood profiles for the Mary Wilson Drain, H.G. Kenyon Drain, J.M. Thompson Drain, and Highway Run are shown on Figures 6-2 through 6-5. The corresponding floodplain limits were also delineated on the Stream Inventory Maps (Section 3.7 of Chapter 3).

Mary Wilson Drain

The lower reaches of Mary Wilson Drain are impacted by backwater from Cool Creek. The backwater results in overtopping of 151st Street. There are six private drive culvert crossings upstream of 151st Street. Five of these drives are overtopped during the 100-year storm event. The floodplain is generally narrow and there are no buildings or structures in the floodplain.

H.G. Kenyon Drain

H.G. Kenyon drain has limited roadway overtopping problems. A private drive upstream of US 31 and two private drives downstream of Oak Ridge Road are overtopped during the 100-year storm event. The floodplain is generally narrow, but widens somewhat downstream of Oak Ridge Road where the channel is poorly defined. There may be a building in the floodplain between Oak Ridge Road and Montrose Lane.

J.M. Thompson Drain

The first stream crossing on the J.M. Thompson Drain (Jersey Street) is impacted by backwater from the Anna Kendall Drain. The other two stream crossings on this drain (Main Street and Catherine Drive) can safely pass the 100-year storm event. However, the Main Street culvert creates significant headwater, resulting in a wide upstream floodplain. Six structures along the lower end of J.M. Thompson Drain are flooded by the backwater from Anna Kendall Drain. Numerous structures upstream of Main Street are within the 100-year floodplain.

Highway Run

The US 31 culvert creates significant headwater during the 100-year storm. This headwater impacts the culverts in the vicinity of Walter Street and Walter Court. Five stream crossings of the Highway Run are overtopped during the 100-year event, four in the vicinity of Walter Street and Walter Court, including Thornberry Drive. Rohrer Drive is also overtopped during the 100-year event. There are numerous buildings in the 100-year floodplain, especially downstream of Walter Court.

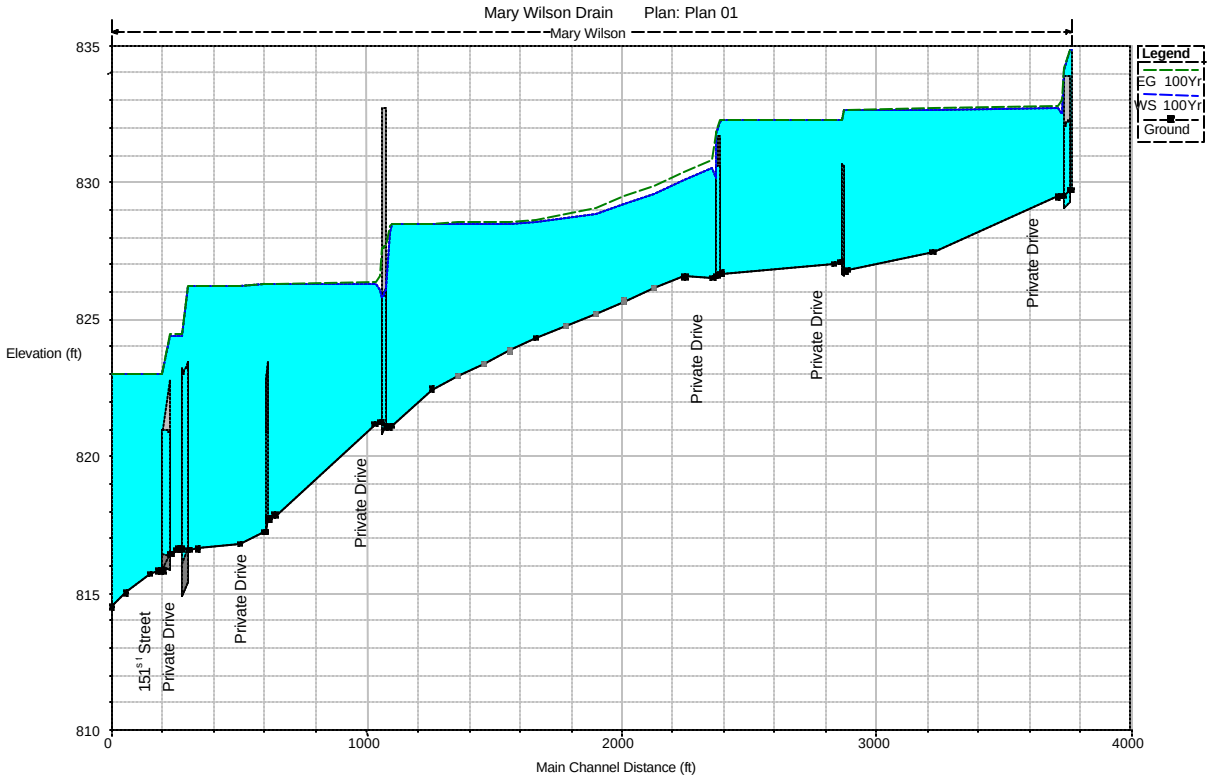

Figure 6-2
Mary Wilson Drain – 100-year Flood Profile

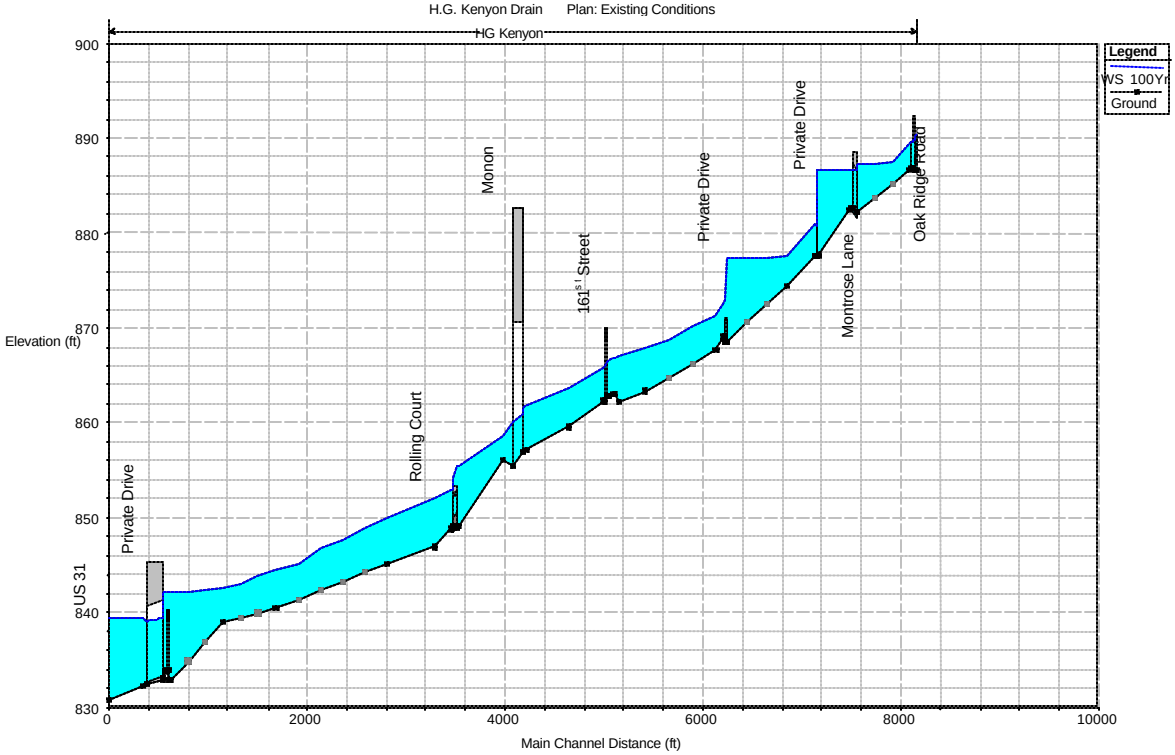

Figure 6-3
H.G. Kenyon Drain – 100-year Flood Profile

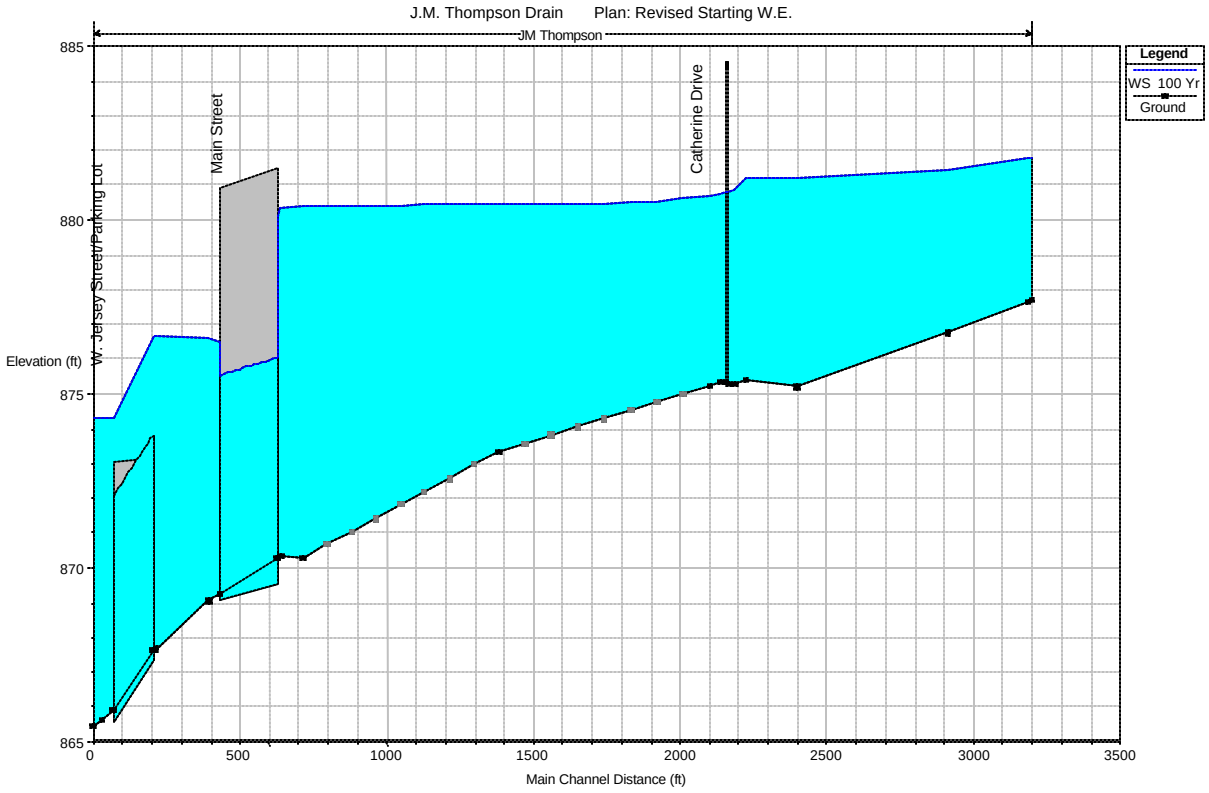

Figure 6-4
J.M. Thompson Drain – 100-year Flood Profile

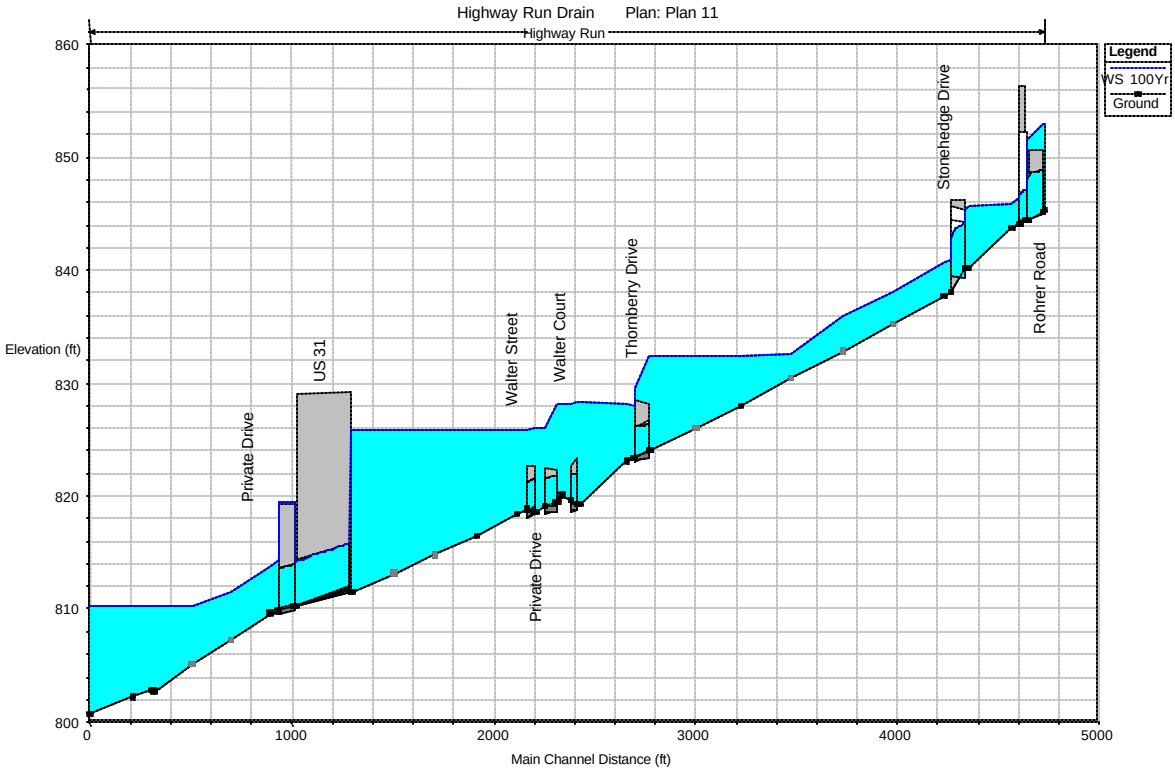

Figure 6-5
Highway Run Drain – 100-year Flood Profile

6.4.2 Existing FIS Model Results

The existing FIS HEC-RAS models (converted from HEC-2) provided model results nearly identical to the flood profiles contained in the Flood Insurance Study reports for Hamilton County, Westfield, and Carmel. The models predict the following roadway overtopping problems areas during the 100-year event.

Cool Creek

- E. 151st Street
- Oak Road
- S. Union Street/Westfield Boulevard
- Private Drive
- Oak Road
- 171st Street

Hot Lick Creek

- Carmel Drive

Anna Kendall Drain

- Four private drives
- Gurley Street
- Cherry Street
- Park Street
- Abandoned railroad embankment

The above results show that conveyance problems are much more pronounced in Westfield. Both Cool Creek and Anna Kendall Drain have several roadway crossings that would be overtopped during significant rainfall events.

A review of the Stream Inventory Maps shows some buildings in the 100-year floodplain of Cool Creek. Most are in the lower portion of the stream, downstream of 116th Street. There are approximately 12 building structures in the floodplain along Cool Creek downstream of Hazel Dell Parkway. This reach of Cool Creek is in the 100-year backwater area of the White River. Four buildings in the vicinity of 116th Street are in the floodplain. Other locations along Cool Creek with isolated buildings or structures in the floodplain are south of 136th Street, north of 151st Street, near 156th Street, and east of Grassy Branch Road. Anna Kendall Drain, along SR 32, has isolated buildings in the floodplain.

6.5 SUMMARY AND CONCLUSIONS

Hydraulic analyses were performed on Cool Creek and its major tributaries utilizing previously developed and new models developed during this project. The models were used to identify roadway overtopping and structures in floodplains. The models were also used to develop solutions to selected problem areas (Chapter 7). The hydraulic analyses lead to the following conclusions:

- The lower reaches of Cool Creek (in the City of Carmel) have limited flooding problems. No roadways are overtopped and limited structures are in the floodplain. Major upstream regional flood control facilities would provide limited benefit. Continued enforcement of the County's detention policy will effectively control 100-year discharges in the future.

- Stream related flooding is more pronounced in Westfield where several roadways along Cool Creek, Anna Kendall Drain, J.M. Thompson Drain and Highway Run are overtopped. Conveyance and/or storage solutions should be considered in these areas.